

1. On the Generic Position of the so-called *Physæ* of Australia. By the Rev. A. H. COOKE, M.A., F.Z.S.

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The freshwater Mollusca of Australia, regarded as a whole, present only one feature which can be considered at all remarkable, namely the extraordinary development of the genus *Physa*. In a valuable paper "On the Freshwater Shells of Australia"<sup>1</sup>, Mr. E. A. Smith enumerates no less than 52 species of this genus. It is true he admits that some of these are undoubtedly synonymous with others<sup>2</sup>; but even if we were bold enough to reduce the number by half, 26 would still remain a large proportion. This is especially evident when we recollect that only eight or nine species of Australian *Limnæa* are known, and only about seven of *Planorbis*. Professor Tate and Mr. Brazier, in their 'Check-list of the Freshwater Shells of Australia'<sup>3</sup>, enumerate 54 species of *Physa*<sup>4</sup>, "more than half [the number] for the whole world."

These Australian *Physæ* present, as a group, certain well-marked characteristics. They are, as a rule, remarkably large, thick shells, sometimes gibbous, sometimes much acuminate, sometimes surmounted with sharp ridges or keels. The columellar fold is generally strong, and in many cases there is present a stout epidermis.

It does not appear that the animal of many of these species has been examined in order to see whether they had anything in common with *Physa* besides the possession of a sinistral shell. One would have thought that the presence or absence of the tongued mantle, reflected over the shell, would have been noticed whenever the animal had been examined.

This group of *Physa* is not peculiar to Australia, though it finds its most extensive development there. Shells of exactly the same facies occur in New Caledonia<sup>5</sup> (14 species), Tasmania<sup>6</sup> (12 species), New Zealand<sup>7</sup> (8 species), Tonga Islands<sup>8</sup> (2 species), Viti Islands<sup>9</sup> (2 species), New Guinea<sup>10</sup> (3 species). This fact confirms the close

<sup>1</sup> Journ. Linn. Soc., Zool. xvi. 1833, pp. 255-317.

<sup>2</sup> I have noted the following as probable:—*proteus*, Sowb., = *pyramidata*, Sowb., + *dispar*, Sowb., + *pectorosa*, Conr., + *breviculmen*, Sm., + *badia*, Ad. and Ang., + *concinna*, Ad. and Ang., + *texturata*, Sowb.: *gibbosa*, Gld. = *producta*, Sm., + *beddomei*, N. and T., + *fusiformis*, N. and T.: *recevi*, Ad. and Ang., = *carinata*, H. Ad., + *obesa*, H. Ad., + *truncata*, H. Ad., + *bonus henricus*, Ad. and Ang., + *eumingii*, H. Ad.

<sup>3</sup> Proc. Linn. Soc. N. S. Wales, vi. 1882, pp. 552-569.

<sup>4</sup> Including Tasmanian species.

<sup>5</sup> Various papers in the 'Journal de Conchyliologie.'

<sup>6</sup> R. M. Johnston, Proc. Roy. Soc. Tasm. 1878, pp. 19-29.

<sup>7</sup> Tenison-Woods, Proc. Linn. Soc. N. S. Wales, iii. 1879, p. 139.

<sup>8</sup> Mousson, Journ. de Conch. 3rd ser. xi. 1871, pp. 17, 18.

<sup>9</sup> Mousson, Journ. de Conch. 3rd ser. x. 1870, pp. 130, 131.

<sup>10</sup> Tapparone-Canefri, Ann. Mus. Gen. xix. 1883 (two species common to Australia).

relationship between these groups of the South Pacific, which is already indicated by the distribution of *Rhytida*, *Janella*, and *Placostylus*.

The object of this paper is to show that these so-called '*Physæ*,' the sole claim of which to the title is that they are sinistral fresh-water-shells, are not *Physæ* at all, but a group of sinistral *Limnæidæ*, characteristic of the geographical area above indicated, and also of another part of the world, where their presence is of extreme interest.

This view rests primarily upon an examination of the radula of some of the species concerned.

As is well known, the radulæ of the *Physidæ* and the *Limnæidæ* are essentially different, and tend to remove *Physa* much further away from *Limnæa* than are either *Planorbis* or *Ancylus*. Fischer describes them as follows<sup>1</sup>:—

#### PHYSIDÆ.

Radula composed of teeth obliquely arranged; central tooth multicuspid; laterals and marginals pectinate or serriform, and provided with a special narrow appendage on the upper and exterior edge.

#### LIMNÆIDÆ.

Teeth of the radula in horizontal rows, bi- or tricuspid [central tooth bi- or tricuspid, never multicuspid]; marginal teeth serriform<sup>2</sup>.

In the 'Journal of Conchology,' v. 1887, pp. 241-243, I described, under the name of *Limnæa physopsis*, a new species of these Australian '*Physæ*.' The reasons given for believing the species to be *Limnæidan* and not *Physidan* were based on (1) a consideration of the radula, and (2) the general facies of the shell. It was suggested, purely on grounds of general similarity of *shell*, that two other Australian species of '*Physa*,' viz. *P. hainesii*, Tryon (= *latilabiata*, Sowb.), and *P. newcombi*, Ad. and Ang., were also *Limnæidæ*.

Since that date several other species of this group of '*Physa*' have been examined, and with similar results. It may at once be asserted that, in spite of the 52 or 54 species enumerated, *Physa* has yet to establish its claim to be an inhabitant of Australia. Every species as yet, which has been examined anatomically, turns out not to belong to that genus; and I am strongly of opinion that further investigation of the animals of the species as yet known only by the shells will afford more evidence of a similar kind.

The note of suspicion has already been sounded more than once with regard to these Australian *Physæ*. Mr. R. M. Johnston has noticed a "peculiar arrangement" of the lingual teeth in *P. tasmanica*, the medials of which are 2-cuspid, the laterals 4-, 5-, and 6-cuspid, the extreme ones having a resemblance to the closed digits of the hand<sup>3</sup>.

<sup>1</sup> Manuel de Conchyliologie, pp. 503, 510.

<sup>2</sup> It may be remarked that this description is inadequate, so far as *Ancylus* proper is concerned.

<sup>3</sup> Proc. Roy. Soc. Tasmania, 1878, pp. 19-29: he uses the term laterals to include marginals as well.

Professor Hutton, examining "*Bulinus gibbosa*, Gld. (*Physa*)?," notices that the edge of the mantle is simple and not reflected over the shell; that the radula has 126 rows, with formula 27-1-27; he goes on to characterize the teeth at length. *Bulinus variabilis*, Gray (*Physa*), is also described as being similar in form of radula, rows 112, formula 18-1-18; and the belief is expressed that probably the other species of *Physa* described from New Zealand will all be found to belong to the same genus<sup>1</sup>.

Professor Tate has expressed a belief that the sinistral spiral Pond-Snails of Australia have been incorrectly placed in the genus *Physa*. He remarks<sup>2</sup> that in no instance has he found in the species those distinctions which characterize *Physa* as separate from *Bulinus*. He observes that the mantle-margin is neither expanded nor digitate, and he catalogues 10 species as *Bulinus*.

Tapparone-Canefri describes<sup>3</sup>, as belonging to *Physa*, the new section *Physastra* with the single species *Ph. vestita*. From his description of the shell, however (form of *Limnæa*, but sinistral, thicker than the common type of *Physa*; surface not shining, but covered with a somewhat thick epidermis, which easily comes off when dry), it is plain that he is dealing with a specimen of the group now under investigation. He figures the specimens, but his examination of the animal was unfortunately not successful.

The following species of this group have been examined<sup>4</sup>, and the results appended have been arrived at:—

#### *General Characteristics.*

Radula long, rather broad, consisting of 140-220 rows; central tooth not equal in size to first lateral, bicuspid; cusps rather blunt; laterals and marginals together about 30-40 in number; laterals 7-12, tricuspid; cusps not much differing in length; passage to marginals gradual; marginals serrate, often much curved at extreme edge, where they become very small and less serrate.

#### PHYSA GIBBOSA, Gld. (figs. 1, 1 a).

Radula with about 144 rows; cusps of central tooth very blunt; laterals 7-8, horizontal. Formula 22-8-1-8-22.

*Hab.* Australia.

#### PHYSA PROTEUS, Sowb. (figs. 2, 2 a).

Radula with about 83 rows (specimen probably imperfect), very similar to *gibbosa*. Formula 27-8-1-8-27.

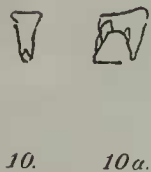
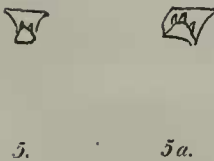
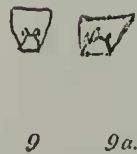
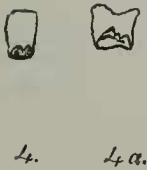
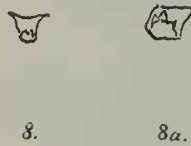
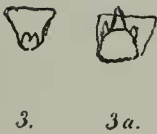
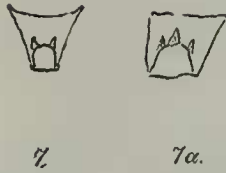
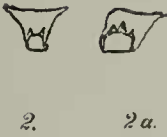
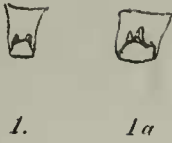
*Hab.* Australia.

<sup>1</sup> Trans. N. Z. Inst. xiv. 1881, p. 155. *Bulinus* must surely be a misprint for *Bulinus*, and the formula of *B. variabilis* is a little suspicious.

<sup>2</sup> Trans. Roy. Soc. S. Austr. v. 1882, p. 51.

<sup>3</sup> "Fauna Malacologica della Nuova Guinea," Ann. Mus. Stor. Nat. Genova, xix. 1883.

<sup>4</sup> All the specimens have been prepared by and are in the collection of Mr. H. M. Gwatkin, M.A., of St. John's College, Cambridge.



Central and first lateral Teeth of so-called *Physæ*, &c.

Fig. 1. *P. gibbosa*. Fig. 2. *P. proteus*. Fig. 3. *P. sinuata*. Fig. 4. *P. tabulata*. Fig. 5. *P. alicia*. Fig. 6. *P. multistrigata*. Fig. 7. *P. physopsis*. Fig. 8. *P. scalaris*. Fig. 9. *Planorbis corneus*. Fig. 10. *Limnæa stagnalis*.

*PHYSA SINUATA*, Gld. (figs. 3, 3 a).

Radula with about 83 rows (specimen probably imperfect); laterals rather more extensive than in the other species; outer cusp very small. Formula 25-12-1-12-25.

*Hab.* Viti Islands.

*PHYSA TABULATA*, Gray (figs. 4, 4 a).

Radula with at least 220 rows; extreme marginals very much curved. Formula 32-8-1-8-32.

*Hab.* New Zealand.

*PHYSA ALICIÆ*, Reeve (figs. 5, 5 a).

No special features. Formula 25-7-1-7-25.

*Hab.* Australia.

*PHYSA MULTISTRIGATA*, Tate (figs. 6, 6 a).

Formula 30-8-1-8-30.

*Hab.* Australia.

*PHYSA PHYSOPSIS*, Cooke (figs. 7, 7 a).

Radula large, rows about 140; laterals numerous. Formula 30-9-1-9-30.

*Hab.* Australia.

*PHYSA SCALARIS*, Dkr. (figs. 8, 8 a).

Rows about 140, not so much curved as in the other species; passage between laterals and marginals not distinctly marked. Formula about 25-7-1-7-25.

*Hab.* Angola.

Several interesting facts follow on this investigation. In the first place, the teeth of the radulæ bear a very striking resemblance to those of the African genus *Isidora*, Ehrenb. So far as I am aware, the radula of *Isidora* has only once been figured, namely by Jickeli in his 'Fauna der Land- und Süßwasser-Mollusken Nord-Ost-Afrika's'<sup>1</sup>. The resemblance amounts to identity; in *Isidora* the central tooth is squarish, bicuspid, the laterals tricuspoid, the marginals serrate, just as in these Australian '*Physæ*,' and the shells present no difference whatever. Fischer, therefore, is quite right<sup>2</sup> in regarding the Australian and African genera as the same, and thus a most remarkable link is established between the molluscan fauna of Australia and Africa, a link in the chain of evidence already afforded by the existence of the carnivorous Land-Shells (*Rhytida*) in both Continents, and, amongst the marine Mollusca, by the occurrence of identical species of such littoral shells as *Purpura* and possibly of *Littorina*.

In the next place, the relation of the group is much closer to *Planorbis* than to *Limnæa*. A comparison of the central tooth and first lateral of *Plan. corneus* and of *Limn. stagnalis* (see figs. 9, 10,

<sup>1</sup> Nova Acta Ac. Nat. Cur. xxxvii. 1875, Taf. iii. figs. 2-4.

<sup>2</sup> Manuel de Conchyl. p. 509.

p. 139) with the same teeth of these *Bulini* will make this clear. In *Planorbis* the central tooth is broad-based, bicuspid, while the laterals are tricuspid; in *Limnæa* the central tooth is long and narrow, unicuspid, while the laterals are bicuspid. A *Bulinus*, therefore, is not so much a sinistral *Limnæa* as a spiral *Planorbis*. Further research, as the animals of more species are investigated, may, perhaps, bring out some points of difference leading to division into subgenera of the Australian and Austro-Polynesian species. It is possible that the somewhat wing-shaped form of the central tooth in some cases (see figs. 2, 3, 5, 7, 8, p. 139), as compared with its more regularly square shape in others (see figs. 1 and 4), may indicate a basis of subdivision; but at present there does not seem sufficient material to work upon.

Finally, as regards nomenclature.

Adanson, in 1757, described and figured<sup>1</sup> under the name of Le Bulin or *Bulinus* a small sinistral freshwater shell from Senegal, length  $1\frac{1}{4}$  lines, breadth  $\frac{3}{4}$  line. The shell is evidently not adult, but the description and magnified drawing of the animal, which shows none of the produced mantle-lobes of a true *Physa* (indeed, Adanson fortunately remarks, "le manteau tapisse tout l'intérieur de la coquille sans sortir au-delà des bords de son ouverture"), are sufficient to enable us to recognize it as belonging to the genus now under investigation. Fischer, therefore, is quite right in adopting *Bulinus* as the generic name<sup>2</sup>.

*Isidora* (Ehrenb. 1831) is a synonym, see Jickeli, *loc. supr. cit.*

Fischer, in his 'Manuel,' goes on to enumerate five subgenera, viz. *Pyrgophysa*, *Plesiophysa*, *Ameria*, *Glyptophysa*, and *Physopsis*.

*Pyrgophysa* was proposed by Crosse<sup>3</sup> for *Ph. mariei*, Crosse, from Nossi-Bé, on the ground of its turreted spire. But this subgenus is of little value, as the Australian species present every variety of such formation. Crosse's description of the shell ("haud nitens, vestimento opaco induta") makes it plain that it belongs to this genus.

*Plesiophysa* (Fischer, 1883) includes the remarkable *Ph. striata*, d'Orb., from Guadeloupe. This must be the '*Physa* sp.' from Point à Pitre<sup>4</sup>, the radula of which is described by Bland and Binney<sup>5</sup> as follows:—"Central tooth 5-cusped, central of these the largest; laterals 4-cusped, one inner, large, stout; marginals a reproduction of the laterals." This description at once removes the species from

<sup>1</sup> Sénégal, pp. 5-7, pl. fig. G. ii.

<sup>2</sup> Yet he remarks: "Étymologie inconnu." Adanson, however, *l. c.*, seems to make it fairly clear when he says:—"Cette dénomination n'a paru lui convenir, parce que l'animal pendant sa vie nage presque continuellement à fleur d'eau, et qu'après sa mort la coquille flotte comme une petite bulle d'air transparente."

<sup>3</sup> Journ. de Conchyl. 3<sup>e</sup> sér. xix. 1879, pp. 208-209; xx. 1880, pp. 141-142, pl. iv. fig. 5.

<sup>4</sup> Mazé (Journ. de Conchyl. 3<sup>e</sup> sér. xxiii. 1883, pp. 30-31) records *Plesiophysa striata* from Point à Pitre.

<sup>5</sup> "Note on a curious form of lingual dentition in *Physa*," Ann. Lyc. N. H. N. York, x. 1873, pp. 255-257, pl. xi. figs. 2, 3.

*Physa*. The differences, however, between its dentition and that of *Bulinus* are very considerable, the central tooth being 5-cusped, cusps sharp, instead of 2-cusped, cusps blunt, the extreme marginals being similar in character to the laterals, instead of entirely different, with no trace of serration. Further, the occurrence of the species on an island in the Antilles raises a difficulty on the score of distribution, if its close connection with *Bulinus* be pressed. It seems, therefore, better on every ground to separate off *Plesiophysa*, in the expectation that its congeners will hereafter be found rather on the South-American than the African continent.

*Ameria* (H. Ad., 1861) was proposed for *Physæ* with keeled whorls, e. g. *P. alicia*, Reeve. The distinction is untenable. Every gradation of keeling is observable in the Australian *Bulini*, and occasionally the same species is indifferently keeled or perfectly smooth.

*Glyptophysa* (Crosse, 1872<sup>1</sup>, not 1870; Fischer, 'Manuel') was meant for similar shells, and must share a similar fate.

*Physopsis* (Krauss, 1848) has a truncated columella and lustrous shell. Fischer regards it as a subgenus of *Bulinus*, but it does not appear that the animal has ever been investigated. There is nothing, therefore, to show that it belongs to *Bulinus* rather than to *Physa*.

*Physastra* (Tapp.-Can., 1883) has been dealt with above.

Thus reorganized the genus will read as follows:—

BULINUS, Adans. 1757.

*Etymology*. Diminutive of *bulle*, a bubble.

*Synonyms*. *Isidora* (Ehrenb., 1831), *Diastropa* (Gray, 1840), *Ameria* (H. Adams, 1861), *Glyptophysa* (Crosse, 1872), *Pyrgophysa* (Crosse, 1879), *Physastra* (Tapp.-Can., 1883).

*Animal* without the produced and reflected mantle-lobes of *Physa*; radula Limnæidan, approaching *Planorbis* rather than *Limnæa*; central tooth bicuspid; cusps rather blunt, base square; laterals tricuspid; marginals serrate. Laterals about 6 to 10, marginals about 25 to 33. Number of rows varying between 140 and 220.

*Shell* sinistral, resembling that of *Physa*, acuminate or gibbous, smooth or keeled; texture somewhat thick, covered with a deciduous epidermis; columella strong, often reflected; umbilicus sometimes very wide and deep.

*Distribution*. Australia, Tasmania, New Zealand, New Guinea, New Caledonia, Viti and Tonga Islands; Africa, N., N.E., W., and S.; S. France, Spain, and all countries bordering the Mediterranean<sup>2</sup>.

? Subgenus *Physopsis* (Krauss, 1848). Animal unknown; shell with truncated columella.

*Distribution*. Natal.

<sup>1</sup> Journ. de Conchyl. 3<sup>e</sup> sér. xii. 1872, p. 151; type *petiti*, Crosse, and *alicia*, Reeve.

<sup>2</sup> Tryon (Struct. and Syst. Conch. iii. p. 101) mentions, but I have failed to trace on what authority, that sinistral Limnæas occur in the Sandwich Islands. His whole arrangement of the present group is destitute of scientific value.